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SUSTAINABLE DEVELOPMENT OF LOGISTICS CLUSTERS IN GREEN TRANSPORT CORRIDORS

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Abstract. In the White Paper on Transport 2011 the European Commission stressed the concept of green transport corridors, i.e. transshipment routes with concentration of freight traffic between major hubs and by relatively long distances of transport marked by reduced environmental and climate impact while increasing safety and efficiency with application of sustainable logistics solutions. Green transport is based on inter-modality, powerful logistics hubs and advanced ICT-systems improving traffic management, increase efficiency and better integrate the logistics components of a corridor. Sustainable hub development along the transshipment routes of green corridors is one of the major tasks of green corridors in order to safeguard and meet the necessary corridor performance for the current and future transport demand. The main corridor hubs represent logistics clusters in the sense of Yossi Sheffi, comprising ports, logistics centers and other transshipment nodes. The paper will present results about the development of core logistics clusters representing hubs in green transport corridors and it will indicate actions for hub development with a future-oriented compilation of sustainable development measures of infrastructural, legal or organizational nature. Since the author took part in some important green transport corridor initiatives around the Baltic Sea, including "East-West Transport Corridor (EWTC II)" initiative, representing the first European project which delivered a green corridor manual formulating recommendations and requirements of green transport corridors to European level, some case studies from EWTC project will be discussed.

Keywords: sustainability, logistics cluster, hub development, green transport corridors

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1. Introduction

Regionally concentrated business activities, i.e. regional agglomerations of companies firms drawing economic advantages from their geographic proximity within the same industry, have been in the focus of economic research already for a long period (Marshall 1920; Peneder 1997; Porter 1998, 2000). Already Alfred Marshall (1920) hypothesized in his classic work "Principles of Economics" that the development of industrial complexes implies the existence of positive externalities of co-location based on three main forces, the knowledge sharing and spillover among the co-located firms, the development of specialized and efficient supplier base, and the development of local labour pools with specialized skills. Michael Porter (1998) provided a framework for cluster analysis by focusing on the competitive

advantages and the increased innovation offered by clusters, due to affected competition through an increase of productivity of the collocated companies, an increase of innovation speed, and a stimulation of the formation of new businesses. Most of the studied clusters in academic literature are related to ICT, life science, automotive industry and other industrial clusters, but there exists nearly nothing about logistics clusters until Yossi Sheffi (2012) published his book.

In his understanding "logistics intensive clusters" are agglomerations of several types of firms and operations providing logistics services and logistics operations of industrial firms and operations of companies for whom logistics is a large part of their business. Such logistics clusters also include firms that provide services to logistics companies like maintenance operations, software providers, specialized law firms or international financial services providers (Sheffi 2013).

In order to promote and facilitate green and sustainable transportation the European Commission (EC) introduced the concept of Green Transport Corridors (GTC) in their Freight Transport Logistics Action Plan (FTLAP 2007) which was meant to "reflect an integrated transport concept where short sea shipping, rail, inland waterways and road complement each other to enable the choice of environmentally friendly transport". The initial concept of GTC was only dedicated to the freight transportation so that the passenger transport was only considered as an external effect (road congestions, infrastructure improvements, etc.). In recent years, on European and also on national level an increasing number of initiatives have been started and realised to speed up the shift towards greener and more efficient freight logistic solutions in Europe. Important steps on EU level in this development process have been the Green Paper on TEN-T from 2009, as well as the TEN-T Policy Review 2011 and the EC White Paper on "A Sustainable Future of Transport" (COM 2011).

A green transport corridor can be seen as a network with a relative high number of nodes with relations to other nodes, usually called "hubs". The transported cargo in the GTC is moved, or transhipped, from one hub to another by using different transport mode. All these activities require a sophisticated handling and time and cost oriented planning. Therefore, one of the main activities of green corridors is dedicated to the improvement and development of the underlying transshipment hubs and the removal of existing and future bottlenecks (Daduna *et al.* 2012).

Transshipment hubs differ in their portfolio of products and services depending on the geographical location and on their connection to different transport modes. At the same time transshipment hubs of GTC can be regarded as logistics clusters, or logistics intensive clusters in the sense of Sheffi (2013), where the focus on the cluster development of hubs in green transport corridors should be laid on the bi- or tri-modal combinations of different transport modes and, in an extended form, on the provision of services in the field of warehousing, distribution, and (logistics related) services (van der Lugt and DeLangen 2005; Grundey and Rimienė 2007; Jaržemskis 2007).

This paper focuses on the discussion of sustainable development the logistic clusters in the context of Green Transport Corridors. Different approaches to promote and measure the performance of logistics clusters are presented in the paper and the main research question is how the sustainable development targets of green transport corridors and their underlying hubs, or logistics clusters, can be expressed into a coherent strategic management system.

2. Theoretical frame

Simchi-Levy *et al.* (2003) defined the aim of supply chain management as a set of approaches utilized to efficient integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirement. That means that supply chain management touches the whole cross-company value chain including suppliers, manufactures, customers and disposal companies are involved in the supply chain activities. Green supply chain management is the concept of SCM extended by adding sustainability, i.e. integrating environment thinking, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end-of-life management of the product after its useful life (Shrivastava 2007). By following Adams (2006) we state more precisely that the core of mainstream sustainability thinking has

become the idea of three dimensions, environmental, social and economic sustainability. There exists interdependency between conventional supply chain management and eco-programs (Sarkis 2001). This includes the approach on how ecological aspects can be considered in the whole business processes in the most effectively way. Hervani *et al.* (2005) proposed that green supply chain management practices which include green purchasing, green manufacturing, materials management, green distribution/marketing and reverse logistics. Therefore, it can be assumed that the involvement of green aspects in the supply chain of a company also involves changes in the supply chain itself. Of course, this will then also have an impact on the cooperative alliances with suppliers, manufactures and the customer at the end of the logistics chain but green supply chain management can lead to better performance in terms of indicators such as environmental protection, efficient usage of resources and even to additional turnover due to a green company image (Hunke and Prause 2014).

The concept of green transport corridors of European Union stresses that it will "reflect an integrated transport concept where short sea shipping, rail, inland waterways and road complement each other to enable the choice of environmentally friendly transport". Already the Freight Transport Logistics Action Plan (2007) specified further that the concept of transport corridors is marked by a concentration of freight traffic between major hubs and by relatively long distances of transport, that along these corridors industry will be encouraged to rely on co-modality and on advanced technology in order to accommodate rising traffic volumes while promoting environmental sustainability and energy efficiency, i.e. green transport corridors can be regarded as the platform for medium and long range freight transport and the frame for European green supply chains which are running fully or partly within the corridor.

Since such a transport corridor is realised by a conglomeration of different public and private stakeholders who act along a defined geographical area in order to achieve different goals but with the same objective to reduce costs, increase efficiency, minimize environmental impact and create sustainable logistics solutions. The interactions among actors along the supply chains of big manufacturers suggests that a network perspective may better explain the emergence of collaborative practices and integrative behaviours in logistics in general and supply chain management from organisation's point of view (Lee 2005). The network-based view of supply chains recognizes that the interactions between organisations in a supply chain are rarely as sequential as a chain structure would suggest (Bovel and Martha 2000). As a whole, studies acknowledge the importance of a network structure for the effective diffusion of supply chain-related practices (Roy *et al*. 2006), as well as for efficiency and flexibility of the responses of the supply chain to customer expectations (Wathne and Heide 2004).

From Port-hinterland container logistics fundamental concepts are well known featuring physical and information flows among actors and nodes operating in port-hinterland networks in order to organise powerful and efficient container distribution systems (Rodrigue and Nottebaum 2009). The stakeholders act in those network in a coherent sense and are located in a certain geographical area but the geographical logistics chains are usually shapes rather like trees. The concept of a transport corridor is more restrained where the physical logistics flows are connecting the main hubs in shape of a tubular transport system leading to the perception of a transport corridor as a tubular logistics cluster (Hunke and Prause 2013; Prause and Hunke 2014b). Due to natural reasons transport and logistics activities have often close relations to cluster and networking activities. Transport corridor can be seen as a scale free network. It started from dyadic relationships between two stakeholders and grew to a broader network. Specific characteristics of scale-free networks vary with the theories and analytical tools used to create them, however, in general, scale-free networks have some common characteristics. One notable characteristic is the relative high number of nodes with relations to other nodes which greatly exceeds the average. The nodes, hubs or transhipment hubs, may serve specific purposes in their networks. It turns out that the major hubs are closely followed by smaller ones. These ones, in turn, are followed by other nodes with an even smaller number of degrees and so on (Prause and Hunke 2014b).

Transhipment hubs, logistics clusters or logistics intensive clusters can be defined and classified in terms of their transport functions and their underlying maritime and terrestrial facilities (Daduna *et al.* 2012):

1) Sea port container terminals (SCT) with international hub function and multimodal linkages (Notteboom 2008; Roso *et al.* 2009; Rodrigue and Notteboom 2010; Daduna 2011), within trunk and feeder networks for short sea shipping.
2) Regional and local SCT in the transport corridor with a normally restricted hinterland which constitute the predominant form, e. g. in the Baltic Sea Region.
3) Inland ports with regional and local function and, if applicable, connection to the River-Sea Shipping.
4) Hinterland terminals with supra-regional function (e. g. in the form of Mega-Hubs with the focus on rail / rail transhipment) (Alicke 2002; Rodrigue 2008; Limbourg and Jourquin 2009; Daduna 2011).
5) Regional and local transshipment terminals with (bi- or multimodal) cargo transport, especially taking into account the access to railway freight transport.

These logistics clusters enjoy the same advantages that general industrial clusters, i.e. the increase of productivity due to shared resources and availability of suppliers, improved human networks, including knowledge sharing, tacit communications and understanding, high trust level among companies in the cluster, availability of specialized labour pool as well as educational and training facilities, and knowledge creation centres, such as universities, consulting firms, and think tanks (Sheffi 2013). But Sheffi (2012) also pointed out that logistics clusters show characteristics which make them unique in terms of cluster formation and their contribution to economic growth. Logistics operations may locate in a logistics cluster due to the cluster's role in supporting economies of scope as well as economies of density. Furthermore they provide spill-over capacity for warehousing and transportation; and the ability to cooperate between providers when dealing with demand fluctuations. Logistics clusters also provide a range of employment opportunities in transportation, ICT and other professional jobs, and they diversify the economic basis since they support other industries. Logistics clusters also bear the possibility for improved flexibility by using cooperative slack for all kind of resources including work force (DeLangen 2004; Sydow and Möllering 2013). Logistics clusters, acting as hubs within green transport corridors, also play a crucial role for modal shift from road transport to other modes. According to the White Paper, the demand in road transport has been constantly increasing over the last 20 years, against a steady decrease in rail freight transport. This considered the most important goals of a hub are to: bring together the flow of the freight transport managed by the transport and logistics operators; and to offer very convenient transport and synergic solutions (rail/road/short-sea-shipping) using for instance block shuttle trains on long-range journeys (Europlatforms EEIG 2004).

3. Sustainable cluster development

Clusters and cluster development are widely discussed in academic literature because they allow companies to be more productive and innovative than they could be in isolation and due to low entry barriers for new businesses compared to other locations. Many studies have been realised, analysing different aspects of governance, structure, competitiveness and other issues. Van der Linde (2003) revealed that beyond the diamond approach of Porter, based on factor and demand conditions, additional determinants like the type their emergence, management, financing, related and supporting industries as well as different concepts for strategy and rivalry have an impact on the competitiveness and success of clusters and their development. Of special interest for network and cluster building are "soft factors", like language skills, regional innovation and trust level. There exists a general North – South and West – East down slope within Europe so that the soft factors have been investigated in several studies for Eastern Europe due to an observed weakness in network and cluster in this area (Wölf and Ragnitz 2001; Prause 2010a, b). These studies revealed that knowledge spill-over effects inside the cluster have been regarded as relatively unimportant by the Eastern European managers of the cluster companies. The perception of the interviewed managers was more focused on operational topics like cheap labour and land prices than on strategic soft topics like innovation, cooperation and networking. As a result the authors proposed that initiatives for establishing networks and clusters should rather on the development of soft factors than on pure investments in hard infrastructure. So the underestimation of the soft dimensions is indicating a strategic weakness of the cluster and a threat for the future networking activities and cluster development (Prause 2010a).

These results are in line with the outcomes of the European logistics project "LogOn Baltic" which took place between 2005 -2007 in the Baltic Sea Region.

The project was based on different empiric types of studies and Kersten *et al.* (2007) described in the final project report big differences in the level of the regional networking activities around the BSR and the development of cluster structures in the logistical sector were remarkably underdeveloped, especially in the regions located beyond the Berlin Wall. The project revealed a lack of regional offers for logistics services in Central-Eastern and Eastern Europe and this structural weakness was linked with a general lack in language skills and intercultural experience, i.e. a lack of "soft factors", of the people in the logistics sector.

For Central – Eastern Europe the emergence of new founded clusters is of special importance since most of the traditional clusters collapsed after the fall of the Berlin Wall and huge efforts have been made to establish new clusters. Meier zu Köcker (2008) studied about 100 German initiatives of cluster emergence together with their framework conditions and tried to analyse the long-term impact of special parameters on the cluster performance. His results revealed that crucial parameters for sustainability of cluster initiatives are the clusters organisation and its management, the financing, the quality of cooperation, the level of collaborative R&D development and degree of internationalisation. So the sustainability of the network and cluster development heavily depends on "soft factors", which are part of the regional socio-economic business environment.

4. The Performance of Logistics Cluster

There are a large variety of possible factors influencing the performance of clusters. Furthermore, the performance of companies inside a cluster can only be understood when their integration is taken into account. The most complete measure for the performance of clusters is the value added generated in the cluster. The value added generated in the cluster is the sum of the value added generated by the members of the population. In practice, the measurement of the performance of clusters is a very complicated task because the necessary data for the analysis of the various variables influencing the performance of a cluster are not available.

In his PhD thesis Peter DeLangen (2004) developed a framework for the assessment of the performance of seaport clusters and considered a set of variables influencing the performance of a seaport cluster. He proposed eight variables describing the cluster performance where four variables were dedicated to the cluster structure and another four variables for the cluster governance. Whereas the cluster structures depict mainly the "hard" infrastructure of the sea port cluster, the cluster governance is oriented more on the "soft factors" of the cluster.

Table 1: Performance areas of sea port cluster

Cluster Structure	Cluster Governance
Agglomeration economies	The presence of trust
Internal competition	The presence of intermediaries
Cluster barriers	The presence of leader firms
Cluster heterogeneity	Quality of collective action regimes

Source: DeLangen (2004)

Peter DeLangen tested his analytical framework in an empirical part assessing the seaport clusters of Rotterdam, Durban and the Lower Mississippi Port Cluster (DeLangen 2004). As a consequence, he was able to provide a basis for an assessment of strengths and weaknesses of the structure of the considered seaport clusters and derived from their strengths and weaknesses recommendations for improving the performance of these clusters. A case study according to the analytical framework of DeLangen in the Eastern German Seaport Cluster of Rostock revealed that the intensity of integration of the different service providers into the seaport cluster, representing a logistics cluster in the sense of Sheffi (2013), differed heavily. Characteristics of the seaport cluster in Rostock are the absence of a strong cluster management, a focus on hard infrastructural investments of the available financial means and only a weak link to innovation and qualification institutions. As strength of the logistics cluster have been mentioned the available working power, the high transportation volumes and the low land prices are revealing an emphasis on operating topics in the perception of the cluster companies. When it comes to the weaknesses inside the cluster, the low level of trust was mainly mentioned pointing out again a strategic problem for the future cluster development. But not only level of trust inside the cluster was very low, also the importance of trust for the cluster development was regarded as low by the cluster companies (Biebig and Prause 2007;

Prause and Hunke 2014a).

In comparison a case study of the Western German Hamburg logistics initiative, managing and coordination institution for the Hamburg logistics cluster, with more than 5,000 classical logistics companies and approximately 150,000 employees in the logistics sector proved over the last 10 years a sustainable cluster development around Hamburg seaport. Sustainable financing with a focus on the improvement of the level of cooperation, innovation and qualification, i.e. financial investments into soft factors of the logistics cluster, and strong level of networking and cooperation among the stakeholder, high level of internationalisation, a strong cluster management together with a higher level of trust, compared to the Eastern German Rostock region, were responsible for the generation of more than 10.000 new jobs and an average annual economic growth of about 3% in the logistics cluster (Prause and Hunke 2014a).

Hunke and Prause (2012) illustrated in another case study within the EWTC2 project how cooperation generates synergies in the context of logistics hubs. Since bottlenecks in the infrastructure hinder sustainable hub development the Danish owner of Fredericia port and the ports of Middelfart and Nyborg, ADP A/S (Associated Danish Ports), invested approx. DKK 400 million in the port areas from 2000 to 2010 in order to the port infrastructure. The cooperation of the mentioned ports around Fredericia is one of the best examples of cooperation between ports in Denmark. Operating as one company allows port officials to effectively move equipment (e.g. cranes) and personal to ports where there is demand. This contributes to an effective and efficient operation and realizes ultimate synergy effects. Furthermore, this approach bears the possibility for the administration to diversify the various ports. For example, the Port of Nyborg is being developed to be an important hub for the shipping of windmill blades to points east of Denmark so that the other two ports are able to focus on other industries and products. There are also benefits for clients, whose needs could be better fulfilled by tailor-made offers, with access to three different harbour areas and their infrastructure. The administration and promotion of the ports are also done centrally, which minimizes the costs, something that can be a high burden, especially for smaller ports. Finally, having three harbours in close proximately of each other also gives port officials the chance to re-direct ships to the other ports, if one is fully booked. This could save shippers time and money. All three presented case studies, which are all related to the performance of logistics clusters, underpin the importance of "soft factors" for sustainable cluster development and stress the impact of the variables, linked to the cluster governance in the model of DeLangen, on the long-term success of logistics clusters.

5. Controlling of logistics clusters and green corridors

Since logistics cluster represent hubs in green corridors the issue of monitoring and controlling the performance of those logistics clusters have to be compatible with monitoring and controlling concepts for Green Transport Corridor. The author participated in the European funded project East-West-Transport Corridor (EWTC) under the Baltic Sea Region Programme 2007-2013, where for the first time a "Green Corridor Manual" based on the green EWTC was developed trying to give a holistic and consistent monitoring concept for multi-modal sustainable transport (EWTC 2012). The green corridor manual consists of a set of recommendations and guidelines on how to implement the green corridor concept according to the EU freight agenda and as promoted by the EU Baltic Sea Strategy. An important source for the development of the green corridor manual was the requirements of the green corridor initiative of the Nordic States for green corridor concepts (Green Corridor 2010).

The green corridor manual focusses on the definition of a set of Key Performance Indicators (KPI) and incentives and regulations for more efficient, high quality, safe, secure and environmental friendly transport facilities and services. Such a manual can list indicators and measures with their potential impacts, together with a governance model for the development of a stepwise deployment of this concept. The following table gives an overview about the KPIs which were selected from the EWTC project and were also tested during the project duration (EWTC 2012).

Table 2. Performance areas of green supply chains

Performance areas	Operational indicators	Enabling indicators
Economic efficiency	Total cargo volumes On time delivery	Corridor capacity
Environmental efficiency	Total energy use Greenhouse gases, Co2e Engine standards ISO 9001 dangerous goods	Alternative fuels filling stations
Social efficiency	ISO 31 000 ISO 39 000	Safe truck parking Common safety rating Fenced terminals

Source: EWTC 2012

There are different aspects influencing the performance of the Transport Corridor. The EWTC approach separates these aspects into enabling and operational criteria. Enabling criteria describe the settings of the transport chain in regard to the hard infrastructure, whereas operational aspects highlight the soft infrastructure including the information and communication systems and logistics solution by involving new and innovative business models (Hunke and Prause 2013). The performance areas are furthermore considered under economic, environmental and social aspects representing the three dimensions of efficiency (EWTC 2012). But a deeper view on the proposed KPI show that important "soft factors" for cluster measurement mentioned in the model of DeLangen are not covered by the KPI of the EWTC project.

But the current academic discussion related to performance monitoring of green corridors focusses on different sets of Key Performance Indicators (KPI) for the sustainable management of green corridors are neglecting a network-oriented controlling approach so that a general concept for green corridor controlling is still missing (Sydow and Möllering 2009; Hunke and Prause 2013; Prause 2014). A widespread approach for a network- oriented controlling is based on the balanced scorecard concept of Kaplan and Norton (1996), which has been transferred and adapted to a cross-company interactions leading to "cooperative scorecards" of "network-balanced scorecards" (Hippe 1997; Lange *et al.* 2001; Hess 2002). Ackermann (2003) proposed for the controlling of a supply chain a "supply chain balanced scorecard", where the traditional perspectives related to finance, processes, clients and learning are still maintained but they are oriented on the integral supply chain instead on unique companies or stakeholders. Weber (2002) took one step further and created cross-company balanced scorecard for a supply chain, which keeps the two traditional perspectives finance and processes but he replaced the other two traditional perspectives by two new ones, which he called cooperation intensity and cooperation quality:

- financial perspective,
- process perspective,
- cooperation intensity, and
- cooperation quality.

In his proposal Weber subsumed under the cooperation intensity perspective the "hard factors" of cooperation like data exchange, whereas he used the cooperation quality to focus on the "soft factors" like trust and cooperation. Weber's proposal for a supply chain balanced scorecard has the following structure (Table 3).

Table 3. Weber's modified Supply Chain Balanced Scorecard

Perspective	Strategic target	Indicator	Measures
Financial Perspective	Increase return of SC	Increase RoA of SC by x %	Outsource warehousing Reduce working capital
	Try to achieve cost ledership	Reduce logistics costs in SC per unit by x %	Bundling of partner capacities
Process Perspective	Max. lead time client: 10 days	Reduce SC lead time to 10 days	Cross partner process optimization
	Increase flexibility of operations	Increase freezing point in % of lead time of SC	Flexible parts, postponement
Perspective of Cooperation Intensity	Increase data exchange between SC partners	Number and frequency of exchanged data sets	Improve IT - networking of SC partners
	Increase coordination between SC partners	Number of necessary coordination meetings	Systematic management of notes and minutes
Perspective of Cooperation Quality	Increase trust and satisfaction level between SC partners	Establish indicators for trust and satisfaction	Define common visions and guidelines
	Increase cooperation quality	Number of uncooperative solved conflicts	Establish "referee" for the SC

Source: Sydow and Möllering 2013

Weber's proposal was oriented on the needs of supply chains but like Prause (2014) proposed, due to the conventional proximity between supply chains and green corridor, to use Weber's ideas for constructing a green corridor balanced scorecard which includes the KPI system of the EWTC "Green Corridor Manual" and which respect also the frame conditions of green transport corridor. Prause and Hunke (2014b) exhibited that beside the criteria covered by be EWTC key performance indicators also other aspects like openness, transparency, fair and harmonised access regulations as well as cooperation aspects are common and characteristic frame conditions for green transport corridors which have to be integrated into a strategic management control system.

Consequently as acceptable Green Corridor Balanced Scorecard should again allow four perspectives including all important perspectives for green transport corridors and should additionally focus on the underlying network and cluster properties of a corridor. One possible approach for such a concept for a green corridor balanced scorecard which is in line with a controlling concept for supply chains has been elaborated and proposed by Prause (2014). Even if the set of indicators is not complete and furthermore the type of measurement and evaluation of the indicators is still open this approach integrates the existing knowledge about supply chains, logistics clusters and green transport corridors:

- Sustainability perspective
  - Economic efficiency
  - Environmental efficiency
  - Social efficiency
- Growth perspective
  - Innovation activities
  - New services
  - Green corridor stakeholder fluctuation
  - TO of new services
- Cooperation intensity
  - Data exchange
  - Coordination needs
- Cooperation quality
  - Openness
  - Trust level
  - Transparency level
  - Conflict level

In this sense the presented balanced scorecard represents an important stepping stone for a management control concept for green corridors including the development of its underlying hubs. Especially it comprises the KPI set, the "soft factors" dimension for sustainable logistics cluster development as well as the most important aspects of green corridor management. It is obvious that further research has to be done towards a mature and complete controlling concept for the sustainable development green transport corridors and their underlying network of hubs.

Conclusions

The concept of Green Transport Corridor is highly ranked on the European transport agenda and its performance heavily depends on the underlying hubs which are representing logistics clusters. Therefore sustainable cluster development becomes a major issue in the management of green transport corridors. Until now logistics clusters and their performance and development represent a neglected area in the academic literature. The presented research shows how existing performance measurement and strategic management systems for logistics clusters as hubs of green transport corridors and for green corridors themselves can be combined in a coherent way so that a sustainable development is possible.

On the level of logistics clusters the cluster performance measurement approach of De Langen, based on sea port clusters, has been discussed and illustrated with case studies in the context of sustainable development. Parallel the key performance indicators (KPI) of the "Green Corridor Manual" of the EWTC project have been taken under consideration on the level of the corridor level. Finally the current research in the area of controlling of supply chains and green corridors has been highlighted and discussed on the base of the balanced scorecard concept. As a conclusion a coherent strategic management control system for the sustainable development of green transport corridors including underlying transshipment hubs has been presented.

However, the first experiences of Green Transport Corridors on European level are showing that beyond the development of appropriate KPIs the success and performance of corridors heavily depend on the sustainable development of the underlying network of hubs, which are representing logistics clusters in the sense of Sheffi. For their development "soft factors" are playing a crucial role, which is yet now fully integrated into the systems of management control of green corridors. Future research should be done on coherent controlling concepts of green corridor and their integrated logistics clusters in order to safeguard a sustainable development.

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